THE Japanese BEETLE:

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how to control it

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THE Japanese BEETLE: how to control it

By Walter E. Fleming, entomologist,

Entomology Research Division, Agricultural Research Service

The Japanese beetle,[1] one of our plant pests of foreign origin, is much more destructive in the United States than in Japan, its native land. It was first found in this country, near Riverton, N.J., in 1916. It has increased and spread until, in 1959, it occurred in varying numbers from southern Maine southward into North Carolina, and westward into Ohio and West Virginia. Local colonies of the beetle also exist in several other States westward to the Mississippi River and just beyond it.

DESCRIPTION

Japanese beetles are a little less than ½ inch long, and are shiny, metallic green. They have coppery-brown wings, and six small patches of white hairs along the sides and back of the body, under the edges of the wings. Males and females have the same markings, but males usually are slightly smaller than females.

HABITS AND DAMAGE

The beetles appear first on their favorite food plants early in summer. In eastern North Carolina, they appear in mid-May; in the vicinity of Philadelphia, about June 15; and in New England, about July 1 or later.

The period of greatest beetle activity lasts from 4 to 6 weeks; then the beetles gradually disappear. In eastern North Carolina, most of them are gone by the early part of August; in New England, some are present until frost.

Plate 1 shows how the Japanese beetle looks in its different stages; figure 1 shows its seasonal history.

Japanese beetles fly only in the daytime. They are very active on warm, sunny days, and move readily from one plant to another. They congregate and feed on flowers, foliage, and fruit of plants and trees exposed to bright sunlight.

Types of Injury

Beetles feeding on leaves usually chew out the tissue between the veins, leaving a lace-like skeleton; they may eat away large, irregular areas on some leaves. A badly attacked tree or shrub may lose most of its leaves in a short time.

The beetles often mass on ripening fruits, and feed until nothing eatable is left; they seldom touch unripe fruit.

[1] *Popillia japonica.*

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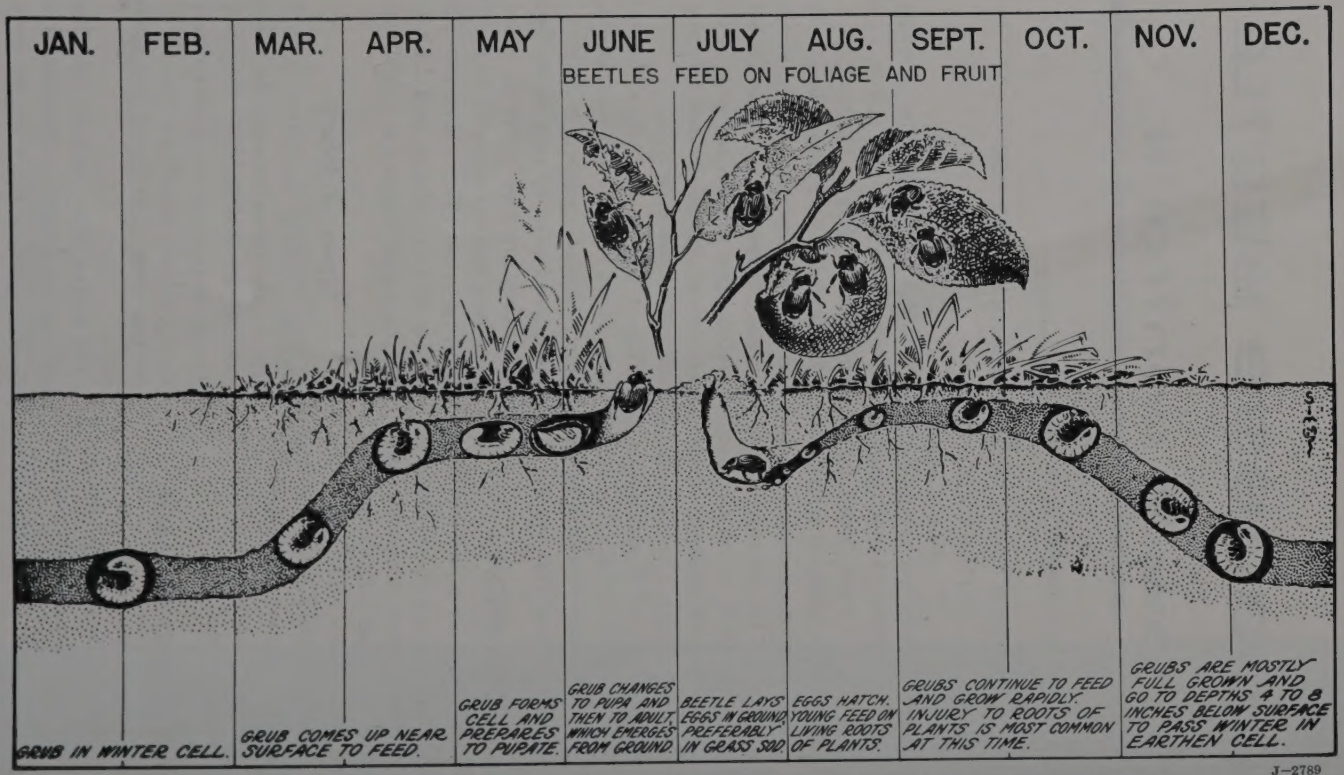
JAN.
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BEETLES FEED ON FOLIAGE AND FRUIT
GRUB IN WINTER CELL.
GRUB COMES UP NEAR SURFACE TO FEED.
GRUB FORMS CELL AND PREPARES TO PUPATE.
GRUB CHANGES TO PUPA AND THEN TO ADULT, WHICH EMERGES FROM GROUND.
BEETLE LAYS EGGS IN GROUND, PREFERABLY IN GRASS SOD
EGGS HATCH. YOUNG FEED ON LIVING ROOTS OF PLANTS.
GRUBS CONTINUE TO FEED AND GROW RAPIDLY. INJURY TO ROOTS OF PLANTS IS MOST COMMON AT THIS TIME.
GRUBS ARE MOSTLY FULL GROWN AND GO TO DEPTHS 4 TO 8 INCHES BELOW SURFACE TO PASS WINTER IN EARTHEN CELL.
J-2789

Figure 1.—**Seasonal life cycle of the Japanese beetle in the vicinity of Philadelphia.**

They seriously injure corn by eating the silk as fast as it grows, which keeps the kernels from forming.

From time to time, the females leave the plants on which they have been feeding and burrow about 3 inches into the ground, usually in turf land. There, they lay a few eggs from which grubs later hatch; then, they return to the plants for more feeding. Where there are extensive cultivated areas, the beetles lay eggs in soil near plants.

Grubs

The Japanese beetle spends about 10 months of the year in the ground, in the form of a white grub. The grub is similar to our native white grub, but usually is smaller—about 1 inch long (fig. 2). It lies in the soil in a curled position.

Grubs feed on the roots and underground stems of plants, particularly grasses. Often, this feeding is not noticed until the plants fail to make proper growth, or are killed. When grubs are numerous, they may cause serious injury to turf.

CONTROL OF BEETLES

Spraying or Dusting

You may protect the foliage and fruit of most plants by spraying or dusting them with insecticide. However, insecticide will not fully protect flowers from this pest.

Timeliness and thoroughness of application are very important. Begin treatment as soon as beetles appear, before damage is done. Use insecticides only on plants for which they are indicated; follow directions on container labels.

Apply insecticide thoroughly, so that all parts of the plant are covered by a protective deposit. More than one application may be necessary to maintain protection, especially of new foliage and ripening fruit; it may be necessary if heavy rain occurs.

Dilute Sprays. Dilute sprays have been used for many years to control beetles on fruit trees, grapes and small fruits, shade trees, ornamental shrubs, flowering plants, corn, and soybeans. Several effective materials are now available for use under different conditions, as described here.

Hand sprayers may be used for low-growing plants. High-pressure equipment is necessary to apply the spray properly to fruit and shade trees and to

J–5128

Figure **2.—Full-grown Japanese beetle grub. Six times natural size.**

the higher ornamental shrubs. In vineyards and in corn and soybean fields, boom-equipped sprayers have given satisfactory coverage.

DDT is one of the most effective insecticides for killing beetles and protecting plants from attack. Many beetles are killed during the spraying operation; others that come to the sprayed plants, during the period when the residue is effective, are killed by contact. Satisfactory sprays can be made with a wettable powder containing 50 percent of DDT, or with an emulsifiable concentrate containing 25 percent.

Do not use an oil solution as sold for use against household insects; it may injure the plants.

To make a spray, mix the wettable powder or the emulsifiable concentrate with water (see table below). Keep the mixture agitated while spraying.

The use of DDT on plants is often followed by an increase in the number of mites. It has little effect on the mites, but destroys their natural enemies. If you find an infestation of mites, consult your county agricultural agent regarding their control.

Do not use DDT on berries or vegetables after the edible portion begins to form, on tree fruits later than 1 month before picking. Do not use it later than 40 days before harvest on grapes or apples receiving more than 5 applications. Do not use it on fodder crops that are to be fed to dairy

Guide for Mixing Sprays

Formulation [1] (purchased product)	Insecticide. Amount to mix with—		
	1 gallon water	10 gallons water	100 gallons water
DDT:			
50-percent wettable powder	1½ tablespoons	3 ounces	2 pounds.
25-percent emulsifiable concentrate.	4 teaspoons	6 fluid ounces	2 quarts.
Methoxychlor:			
50-percent wettable powder	3 tablespoons	5 ounces	3 pounds.
25-percent emulsifiable concentrate.	6 teaspoons	9 fluid ounces	3 quarts.
Malathion:			
25-percent wettable powder	1½ tablespoons	3 ounces	2 pounds.
50-percent emulsifiable concentrate.	1 teaspoon	1½ fluid ounces	1 pint.
Rotenone:			
Wettable powder containing 4 percent of rotenone and 12 percent of total extractives.	3 tablespoons	5 ounces	3 pounds.

[1] These are the usual commercial formulations. If you buy a product of a different strength, use proportionately more or less of it.

animals or to animals being fattened for slaughter.

Methoxychlor kills beetles more slowly than does DDT and is not as effective in preventing reinfestation of the plants. However, it is less poisonous to man and animals, and may be used closer to harvesttime on feed and forage crops and fruits.

Satisfactory sprays can be made with a wettable powder containing 50 percent of methoxychlor, or an emulsifiable concentrate containing 25 percent.

Thoroughly mix the insecticide with water, and keep the mixture agitated during spraying.

The use of methoxychlor should be discontinued 7 days before picking apples, pears, cherries, or plums; 21 days before picking peaches, apricots, or nectarines; or 3 days before picking bramble berries or strawberries; or 14 days before gathering most other crops.

Malathion is very effective in killing beetles, is one of the safest insecticides to handle, and can be applied near harvesttime.

Apply every 7 to 10 days; malathion sprays are not effective for a longer period.

Malathion can be applied to bramble berries, blueberries, beans, or asparagus up to 1 day before harvesttime, to peaches 7 days, and to most other crops 3 days before gathering.

Parathion for control of Japanese beetles should be used only by the commercial operator or grower. It is highly poisonous to human beings if inhaled, absorbed through the skin, or swallowed. It should be applied only by trained operators who are thoroughly familiar with the hazards involved, and who will take proper precautions and assume full responsibility.

Do not use parathion in the home garden.

J-226 B

***Figure 3.*—Dead turf rolled back, exposing Japanese beetle grubs that have been feeding on the roots.**

J–3443

***Figure 4.*—Beetles feeding on grape leaf.**

A spray containing 2 pounds of 25-percent parathion wettable powder to 100 gallons of water is very effective in killing beetles. The deposit on the plants will usually protect them from attack for about 7 days. Make additional applications if the beetles again begin to collect on the plants.

Parathion should be applied to most berries only before the fruit sets or after harvesttime, or to orchard fruits or strawberries not later than 14 days, or to beans 15 days before picking.

Rotenone is contained in materials such as derris, cube, and timbo, which are of particular value in the home yard in driving beetles away from ripening apples, peaches, plums, cherries, grapes, raspberries, and flowering plants.

Use a wettable powder containing 4 percent of rotenone and 12 percent of total extractives. To make a spray, mix the wettable powder with water (see table, page 6).

Apply every 7 to 10 days; rotenone sprays are not effective for a longer time. Rotenone sprays can be used to within 1 day of harvesttime to protect ripening fruits and other crops.

Concentrated Sprays. Satisfactory control of the Japanese beetle on large acreage has been attained by applying concentrated sprays of DDT, methoxychlor, or malathion with aircraft or special ground equipment.

Aircraft spraying is the fastest method of covering large acreages of corn or soybeans.

Do not spray by aircraft when wind velocity is more than 4 miles an hour. Discharge the spray not more than 100 feet above the plants. Allow ample lapping of the swaths.

Usually, aircraft applications are made early in the morning or late in the evening.

When only the ears of corn are to be harvested, apply the spray when about one-fourth of the field is in silk. Use an emulsifiable concentrate containing 25 percent of either DDT or methoxychlor; mix ¾ gallon of the concentrate with 2¼ gallons of water to make 3 gallons of spray for each acre. When the aircraft is equipped to handle concentrated suspensions, 3 pounds of a wettable powder containing 50 percent of either DDT or methoxychlor may be substituted for the emulsifiable concentrate.

As a rule, it is necessary to protect corn only during the silking period of 5 to 7 days. One application, properly timed, will usually give control; however, if there are heavy invasions of beetles into the corn from adjacent fields, a second application 2 or 3 days later may be necessary.

Plate 1.—*A*, Mature grub in spring, feeding on roots in underground burrow. *B*, Pupa in underground cell. *C*, Adult beetle, emerged from earth. *D*, Beetles feeding on smartweed. *E*, Beetles feeding on grape leaves. *F*, Beetles feeding on apple leaves. *G*, Female beetle depositing eggs in soil at bottom of shallow burrow. *H*, Egg. *I*, Egg hatching, and young grubs. *J*, Partly grown grub in fall.

Soybeans grown for seed or soil improvement may be sprayed with DDT or methoxychlor. Two or more applications may be necessary to protect the new growth.

Do not use DDT on corn or soybeans that are to be used for fodder. Use methoxychlor 14 days or more before harvest.

To protect large plantations of blueberries, raspberries, or blackberries, spray with malathion. Use 1 quart of a 50-percent emulsifiable concentrate per acre. Dilute the concentrate with water to make 3 to 5 gallons of spray per acre. Make applications at 10-day intervals. Make the last application at least 1 day before harvest.

Mist blowers, operated from trucks, have been used extensively in the course of cooperative Federal-State control operations for the reduction of populations of Japanese beetles along roadsides and at airports. An emulsifiable concentrate containing 25 percent of DDT, diluted with twice its volume of water, is usually used in this work. The mist is blown into shrubs and trees as the truck moves along at 2 to 4 miles per hour.

Dusts. Good results may be obtained in large acreages of corn by applying 30 pounds per acre of a dust containing 5 percent of either DDT or methoxychlor. Apply with aircraft or a row duster. Direct nozzles of row duster at the ears.

DDT or methoxychlor dust may be used to advantage in the home yard when suitable spraying equipment is not available.

When insecticides are not available, or there are objections to using them about the home yard, some protection to the plants can be obtained by dusting them frequently with hydrated lime.

CAUTION

Any insecticide, when improperly used, may be harmful. Handle all insecticides with care. *Parathion is particularly poisonous. Do not use parathion in home yards or gardens; do not use it in commercial plantings unless you read and follow precautions furnished with it.* Store insecticides in a dry place where they cannot be reached by children or animals. Be careful not to get insecticides into ponds or streams containing fish.

Hand Collection

When only a few small plants are attacked, partial temporary relief from beetle damage may be obtained by collecting the beetles by hand. Jar or shake the shrubs, trees, or individual branches early in the morning, when it is cool and the beetles are quiet. Place a sheet under the plant to catch the beetles as they fall, and drop them into a bucket containing water and a little kerosene. You should do this every day, because more beetles are continually flying in.

Trapping

Extensive use has been made of traps along the margins of the infested area, airports, and elsewhere to obtain information on the distribution of the insect in connection with cooperative Federal-State efforts to retard its spread to new areas. These traps are painted yellow, and baited with a mixture of 9 parts

of anethole and 1 part of eugenol, by volume. Traps are not available for distribution to individuals or community groups.

Where beetles are abundant, traps may catch tremendous numbers without reducing appreciably the damage in the vicinity. In fact, because traps capture less than 25 percent of the beetles in the vicinity and the attractant may draw more beetles into the area, the damage may be increased. Do not use traps to protect plants from attack by beetles.

Cultural Control

Diseased and poorly nourished trees and plants are especially susceptible to attack by beetles. Keep your trees and plants in condition by the proper use of fertilizers and by other measures.

Prematurely ripening or diseased fruit is very attractive to beetles. Remove this fruit from the trees and ground. The odor of such fruit attracts beetles, which then attack sound fruit.

Delayed Planting. Beetles reduce the yield of corn by feeding on the silk and preventing proper pollination. Corn coming into silk when beetles are not abundant is not subject to serious damage. In some sections it is possible to delay planting to avoid damage. Consult your county agricultural agent with reference to planting dates for your section.

Beetles are very fond of certain weeds and other noneconomic plants, such as bracken, elder, evening primrose, Indian mallow, sassafras, poison-ivy, smartweed, wild fox grape, and wild summer grape. These plants in or around a field or orchard are often a continuous source of infestation for the crop. Eliminate them whenever practicable.

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***Figure 5.*—Beetles feeding on silk of corn.**

Sprays and dusts will not give full protection to such flowers as roses, hollyhock, shrub-althea, and zinnia; they unfold too fast and are especially attractive to beetles. When beetles are most abundant on the roses, nip the buds and spray the bushes to protect the leaves. When beetles become scarce, let the bushes bloom again.

Use of Plants Not Subject to Attack. Although the Japanese beetle will feed on about 275 different plants, it feeds sparingly or not at all on many of the more common trees and plants. When planning new ornamental plantings, or modifying established plantings, make more extensive use of trees, shrubs, and other plants that are not preferred by beetles. Select kinds least likely to be seriously injured. Use the following lists as guides in selecting plants.

Plants Subject To Feeding By Beetles [2]

Small fruits: Blackberry, blueberry,* currant, grape,* raspberry,* strawberry.

Orchard fruits: Apple,* cherry,* nectarine, peach,* plum, quince.

Truck and garden crops: Asparagus, beans, okra, rhubarb, sweet corn.*

Field crops: Alfalfa, clover, field corn,* soybean, timothy.

Ornamental shrubs and vines: Azalea (deciduous), barberry, buckeye, butterflybush, crapemyrtle, flowering crab, flowering cherry, flowering quince, Japanese creeper, kerria, lespedeza, rose,* shrub-althea,* trumpetcreeper, Virginia creeper.*

Ornamental garden plants: Canna,* cardinalflower, castor bean, dahlia,* geranium, hollyhock,* mallow,* mashmallow,* marigold, morning-glory, rosemallow,* scarlet sage, snapdragon, sunflower, zinnia.*

Shade trees: Alder, bald cypress, beech, birch, horsechestnut,* larch,* linden,* lombardy poplar,* maple (Japanese and Norway),* oak (chestnut and pin),* planetree, walnut, willow.*

Plants Rarely Fed Upon By Beetles

Small fruits: Dewberry, gooseberry.

Orchard fruits: Pear.

Truck and garden crops: Cabbage, carrots, cauliflower, eggplant, lettuce, onion, parsley, pea, potato, radish, spinach, squash, sweetpotato, tomato, turnip.

Field crops: Barley, oats, rye, wheat.

Ornamental shrubs and vines: Azalea (except deciduous varieties), beautyberry, box, clematis, deutzia, English ivy, euonymus, evergreens, forsythia, honeysuckle, hydrangea, lilac, mockorange, privet, rhododendron, snowberry, spirea, weigela, wisteria.

Ornamental garden plants: Aquilegia, calendula, carnation, chrysanthemum, coreopsis, cosmos, four-o'clock, gladiolus, goldenglow, iris, larkspur, lily, nasturtium, pachysandra, pansy, peony, phlox, sweetpea, tulip, violet.

Shade trees: Ash, catalpa, dogwood, evergreens (except cypress), locust, maple (except Norway and Japanese), oaks (except pin and chestnut), poplar (except lombardy), redbud, sweetgum, tupelo.

CONTROL OF GRUBS

Lawns and Golf Courses

The grass in lawns, parks, and golf courses may be protected from injury by Japanese beetle grubs for several years by top-dressing once with DDT, toxaphene, chlordane, dieldrin, heptachlor, or aldrin, applied at the following rates:

Insecticide	*Ounces per 1,000 square feet*	*Pounds per acre*
Aldrin	1	3
Heptachlor	1	3
Dieldrin	1	3
Chlordane	3⅔	10
Toxaphene	9	25
DDT	9	25

[2] Plants marked with an asterisk (*) are especially attractive to beetles.

The insecticide in the form of a free-flowing dust or granulated formulation may be applied uniformly over the surface by a fertilizer spreader. The formulation selected should have such a percentage of the insecticide that not less than 2½ pounds are required for 1,000 square feet, or 100 pounds per acre.

For a hand application to small areas, the formulation may be mixed thoroughly with several times its volume of sand, soil, fertilizer, or other suitable material, as an aid in distributing it evenly.

Emulsifiable concentrates or wettable powders mixed with water and applied as a coarse spray by means of a boom attached to a sprayer, or with a hose and nozzle, at the rate of 25 gallons per 1,000 square feet or 1,000 gallons per acre, may be substituted for the dry application.

When there is general foliage feeding by the beetles in the vicinity, and an examination of the turf shows that grubs are present, apply one of the insecticides to prevent the grubs from damaging the turf. It is better to apply the treatment before damage has occurred. When the infestation is not noticed until the grubs have seriously injured the grass and quick action is needed to save the turf, use one of the more poisonous insecticides—aldrin, heptachlor, dieldrin, or chlordane.

The insecticide may be applied at any time when the ground is not frozen. After the insecticide has been applied to a lawn, or in a park, it is advisable to wash the material into the ground with a hose. Treated turf may be mowed, watered, and fertilized as usual.

Usually the treatment will kill a high percentage of the full-grown grubs in the turf at the time of application. The speed of insecticidal action will depend on the temperature of the soil—the warmer the soil, the faster the action.

The treatment should practically eliminate several of the annual broods which hatch subsequently in the treated turf. Aldrin and heptachlor are usually effective for 4 to 5 years, dieldrin for 6 to 7 years, chlordane for 8 to 9 years, and DDT and toxaphene for 10 or more years.

DDT, toxaphene, chlordane, aldrin, dieldrin, and heptachlor are poisons. Keep small children and domestic animals away from poisoned grass until it has been watered, or rain has fallen.

Pastures

The grubs may be very destructive to grasses but rarely feed on the roots of clover and alfalfa. A pasture damaged by grubs may be renovated by sowing a mixture of these legumes. These soon provide a good pasture, and are gradually replaced by the original

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Figure 6.—**Beetles feeding on bloom of a sprayed rose plant.**

J–2932

***Figure 7.*—The spring *Tiphia*, a wasplike insect parasite that lives on and destroys grubs of the Japanese beetle. Six times natural size.**

grasses. Consult your county agricultural agent regarding pasture-renovation practices in your area.

The number of grubs in a permanent pasture may be reduced to an unimportant or low level by the application of a bacterial dust containing spores of the contagious milky disease. The diseases of the grubs are discussed in more detail on the next page.

Dust containing the spores is available from commercial sources. Apply the dust at any time when the ground is not frozen. Usually the spore dust is applied at the rate of 2 pounds per acre, in spots 10 feet apart. Use about 1 level teaspoonful to each spot. If applied in spots 5 feet apart, the disease will become established more quickly. In this case, 7½ pounds of spore dust will be required per acre. For spot treatment of an acre or more, use a hand-operated corn planter with a rotary disk seeder, adjusted to deliver approximately 1 level teaspoonful each time it is tripped. Do not expect immediate results, as several years may elapse before the milky disease becomes fully effective.

Gardens

Plowing infested grassland and planting immediately often result in injury by the grubs to the garden plants. Since the grubs do not thrive in plantings of white clover, red clover, alsike clover, soybeans, or buckwheat, it is better to grow one of these as a cover and green manure crop for at least a year before planting other crops or plants.

When the grubs and pupae are near the surface of the ground, many of them are killed by the ordinary plowing, disking, and harrowing operations.

When grubs are causing serious damage to the roots of ornamental plants, one of the insecticides suggested for turf may be applied and mixed with the upper 3 to 4 inches of soil. These residual insecticides are not recommended for the treatment of land growing edible crops, because of the possible hazard to human health. They may be used before planting only where instructions on container labels permit.

NATURAL CONTROLS

Dry Weather

Extremely dry weather during summer destroys many of the eggs and kills newly hatched grubs. Wet summers are favorable to the development of eggs and grubs, and are usually followed by seasons of increased numbers of beetles.

J—2136

Figure 8.—**Applying insecticide to turf with a small spreader.**

Insect Parasites

A number of the more important insect parasites that prey upon this pest have been brought in from Asia. Two of them, the spring *Tiphia* (fig. 7) from Korea and the fall *Tiphia* from Japan, have now become well established in the area first inhabited by the Japanese beetles. These are small, wasplike insects, which can live only on the grubs of the Japanese beetle.

These enemies of the beetle have gradually become established in infested territory where they are important in the natural control of the beetle.

The U.S. Department of Agriculture cannot furnish these parasites in response to requests from individuals or local groups.

Diseases

Japanese beetles and grubs have diseases just as people do. The most important one is caused by tiny germs, or bacteria. It kills many grubs. This disease is called milky disease because in a diseased grub the blood, which is usually clear, assumes a milky appearance. The milky disease germs, or spores, live in the soil for long periods, ready to infect and kill successive broods of Japanese beetle grubs as they move about in the soil, feeding on plant roots. The disease is harmless to human beings, warmblooded animals, and plants.

The milky disease occurred only in limited areas in New Jersey when it was first found and studied. In these localities this disease appeared to be an

important factor in bringing about a marked reduction in Japanese beetle numbers. However, the spread of the disease seemed to be lagging behind the spread of the beetle. A program for speeding up the spread of the disease and using the milky disease organism in a practical way to reduce Japanese beetle populations was carried on by the U.S. Department of Agriculture in cooperation with State and other Federal agencies during the period 1939–53.

Marked reductions in beetle infestation have already been observed in most of the earliest treated areas, largely because of the rapid development of the disease-producing organism under favorable conditions. It must be expected generally, however, that several years may elapse before a reduction in well-established beetle populations may be observed. In some localities climatic or other conditions may be unfavorable for rapid establishment and development of the disease organism.

The spore dust should not be applied to soil treated with DDT, toxaphene, or other insecticides. It is unlikely that there will be sufficient grubs in poisoned soil to permit establishment of the disease.

The Department does not have spore dust available for distribution to private individuals or organizations, but several individuals or companies have been licensed by the Secretary of Agriculture to manufacture and sell it. The material is thus available for use by individuals or community groups.

Other Enemies

The numbers of Japanese beetles are sometimes reduced a little by other enemies. Both beetles and grubs are fed upon by several of the more common birds, including starlings and English sparrows. When fields are being plowed, sea gulls and domestic poultry often consume large numbers of grubs. Moles and skunks also feed on the grubs, although they often cause considerable injury to lawns digging for them.

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